

10/530079  
Rec'd PCT/PTO 01 APR 2005

REC'D 27 NOV 2003

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Pl 1096955

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FILING DATE.

APPLICATION NUMBER: 60/418,169

FILING DATE: October 15, 2002

RELATED PCT APPLICATION NUMBER: PCT/US03/31115

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# PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(b)(2).

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☐ Additional inventors are being named on the \_\_\_\_\_ separately numbered sheets attached hereto.

## TITLE OF THE INVENTION (280 characters max)

MULTIPLE-OUTPUT ILLUMINATOR USING PARABOLIC/ELLIPTICAL REFLECTOR LAMPS

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## ENCLOSED APPLICATION PARTS (check all that apply)

☒ Specification Number of Pages [ 3 ]

☐ CD(s), Number \_\_\_\_\_

☒ Drawing(s) Number of Sheets [ 4 ]

☐ Other (specify) \_\_\_\_\_

☐ Application Data Sheet. See 37 CFR 1.76

## METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT (check one)

☒ Applicant claims small entity status. See 37 CFR 1.27

Filing Fee Amount: \$80.00

☒ A check or money order is enclosed to cover the filing fee

☐ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 02-2135

☐ Payment by credit card. Form PTO-2038 is attached.

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: \_\_\_\_\_

Respectfully submitted,

SIGNATURE

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Date 10-15-02

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REGISTRATION NO. 31,414  
Docket Number: 2138-275

USE ONLY FOR FILING PROVISIONAL APPLICATION FOR PATENT

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## **Multiple-Output Illuminator using Parabolic/Elliptical Reflector Lamps**

### **Introduction**

Dual paraboloid reflector has been used for coupling of light onto a very small etendue target with high efficiency. The applications include smaller imagers in projection displays, and single or multiple fiber optics. For fiber optic illuminations for the neon replacement market, the output will be directed to a side-lit fibers, it is important that the angle of illumination be small so that the intensity profile along the length of the fiber be as uniform as possible. The fiber is usually illuminated from both ends such that the intensity will be even more uniform along its length. One way to implement such a system is to employ 2 illuminators, one at each end of the fiber. A more practical approach is to use 2-output illuminators such that the fibers can be illuminated in a daisy chained fashion. Many of the illuminators that provide the 2 outputs are done by bundling 2 fibers into the same output port of the illuminator. This tends to be inefficient due to the loss in packing the 2 fibers together. Another scheme is shown by the EFO system used in Fiberstars illuminators in which the light output from the lamp is coupled to 2 fibers using 2 separate reflector system. Although the loss of the system is smaller compared to bundling of the fibers, this system does not allow efficient coupling of light into small targets. The invention described by US Patent # 6,227,682 shows a dual paraboloid reflector system that can couple light efficiently into a small target, but does not produce 2 outputs.

Therefore, there exists a need for a system to couple light efficiently from a lamp into 2 fiber optic outputs, or more outputs in general, with small etendues so that longer fibers can be illuminators with more uniform intensities.

### **Description of the Invention**

Figure 1 shows the configuration of a 2-output illumination system where two outputs are provided with a single lamp. It consists of a lamp inside a parabolic reflector, which collimates the light into a parallel beam. The circular output beam is separated into two beams using the mirror 1 and mirror 2 in opposite directions. Considering the output beam reflected by mirror 1, parabolic reflector 1, which is half of a parabolic reflector, is positioned such that it collects the beam from mirror 1 and focus that onto the input of the light pipe 1. The orientation of the parabolic reflector 1 is positioned as shown such that the arc is imaged onto the input of the light pipe with a unity magnification. Similarly, parabolic reflector 2 is placed to collect the output from mirror 2, and focus the light onto the input of the light pipe 2.

The parabolic reflectors 1 and 2 have shapes that are substantially the same as the main parabolic reflector. For generality, the main parabolic reflector can be slightly elliptical and the parabolic reflectors 1 and 2 will be hyperbolic matching to the elliptical reflector to give the best coupling efficiency and substantially unit magnification. The same can

be done by using a slightly hyperbolic main reflector and matching elliptical reflectors 1 and 2.

Although this configuration shows the configuration with two outputs, the same principle can be applied to more outputs. For example, for a 3-output illuminator, the output beam from the parabolic reflector is divided into three 120-degree segments such that 3 mirrors are used to divide the beam and refocus onto 3 light pipes using 3 120-degree parabolic reflectors. The numerical apertures (NA) of the 3 parabolic reflectors and the light pipes are designed with the proper match to the NA's. By the same token, a 4-output illuminator can be made by dividing the output of the main reflector into 4 parts and coupled to the output light pipes using 4 mirrors and 4 parabolic reflectors. This can be generalized to produce an N-output illuminator with N outputs.

Figure 2 shows another embodiment of a 2-output illuminator using elliptical reflectors. Similar to the case in Figure 1, it consists of splitting the output focused beam of the elliptical reflector into two portions, reflected to opposite directions, and refocused to the input of the light pipes using 2 elliptical reflectors.

In one embodiment, the sizes and shape of the elliptical reflectors are all similar. In another embodiment, the sizes of the elliptical reflectors can be different, but with substantially the same ellipticity. Yet, in another embodiment, the main reflector and the other reflectors can have different ellipticities such that the resultant images of the arc at the inputs of the light pipes are substantially unity.

Similar to the case of Figure 1, N-output illuminator with N outputs can be made using N mirrors, N elliptical reflectors, and N light pipes.

Figure 3 shows another embodiment using parabolic reflectors such that the output direction are different from that of Figure 1 using mirror system 1 and 2.

Figure 4 shows another embodiment using elliptical reflectors such that the output direction are different from that of Figure 2 using extra mirrors as shown.

In general, other configurations can be built using the basic parabolic and elliptical reflectors in combination with plane mirrors or prisms for redirecting the beams of light.

The reflectors can be coated with coat coating or colored coating for specific applications.

Lamps used include xenon, metal halide, high-pressure mercury, halogen, etc.

The flat mirrors can be silver coated, multi-layer dielectric coated with wavelength selectivity, aluminum coated, etc. The function of these mirrors can also be implemented by the use of prisms, e.g. a right-angle prism.

The light pipes can be made of plastic, glass, quartz, etc. The output surface can be flat or convex.

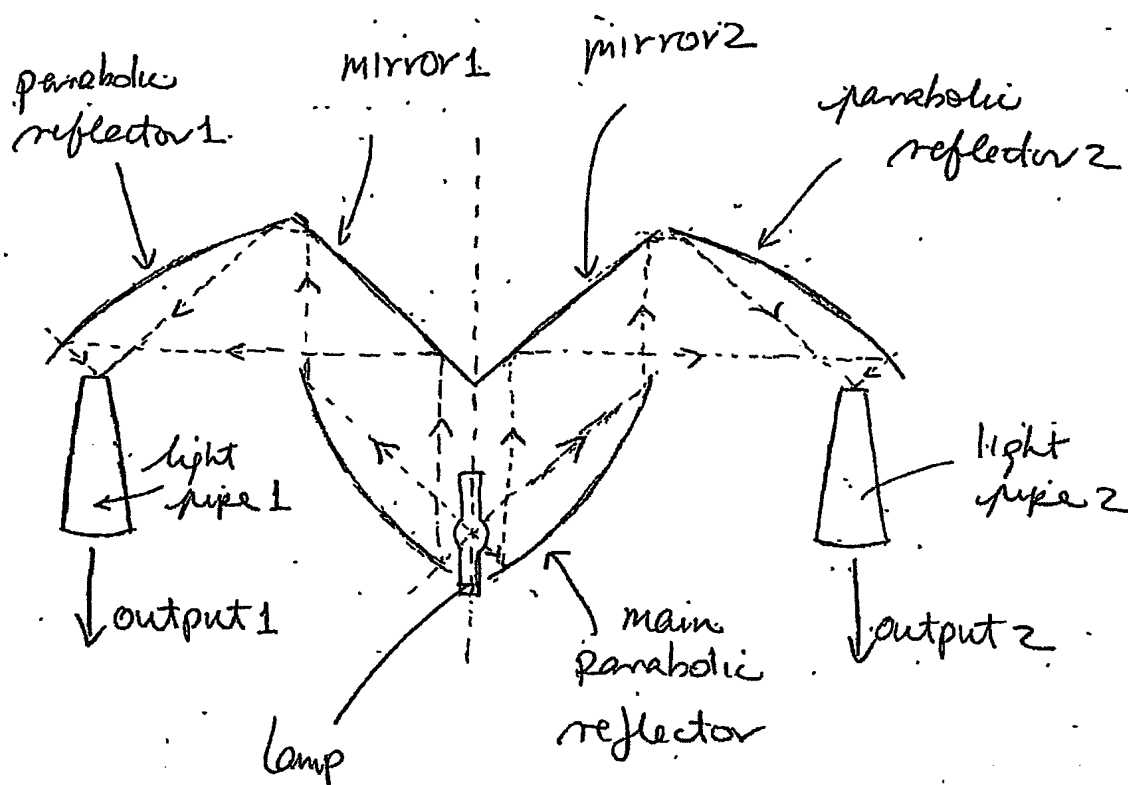


Figure 1

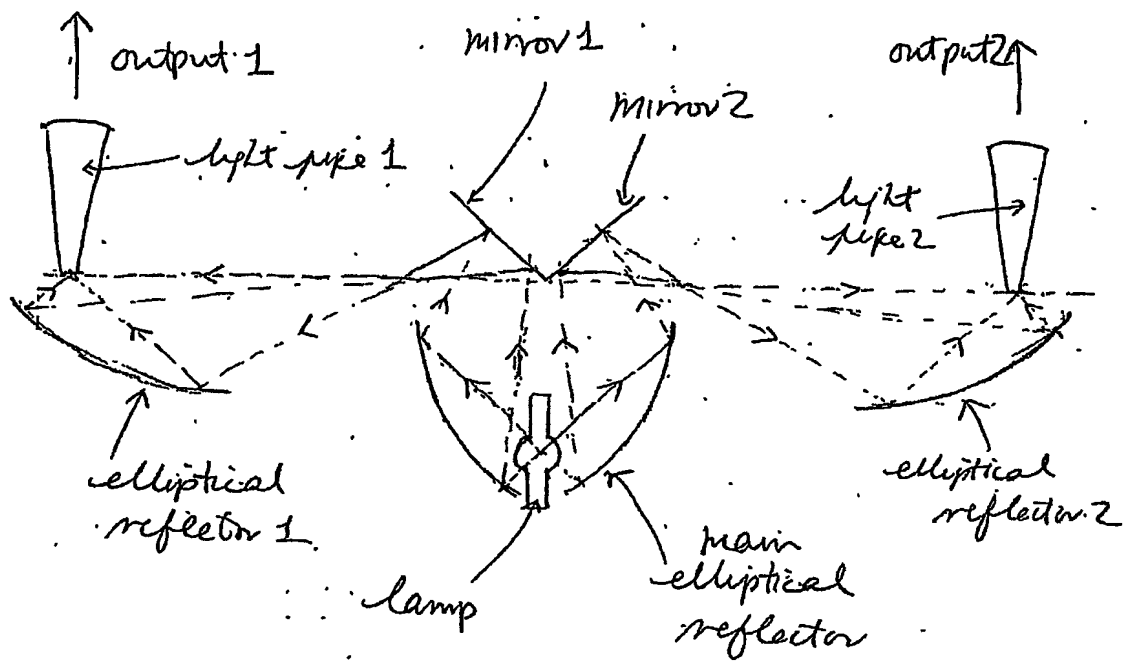


Figure 2

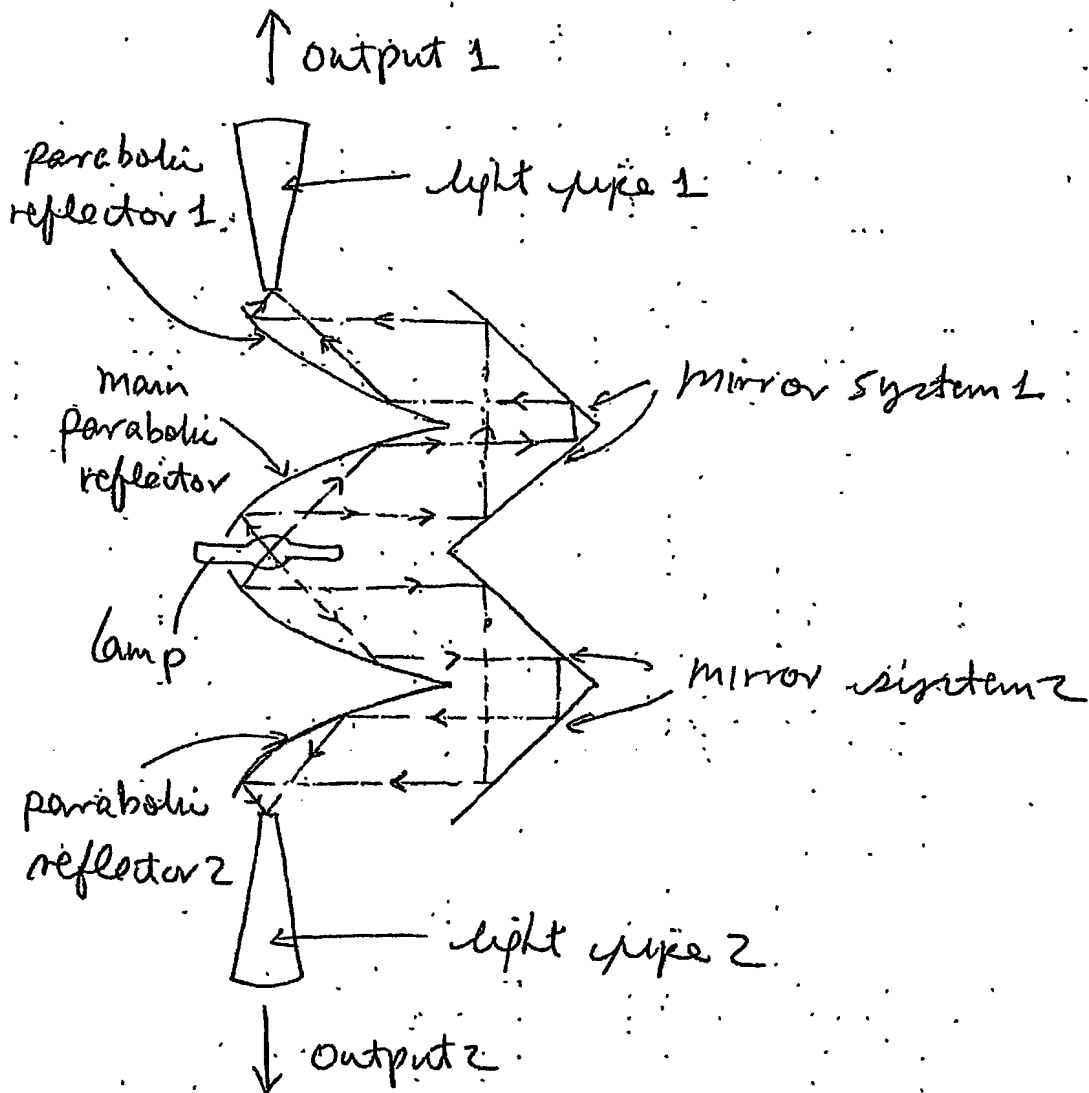


Figure 3



MULTIPLE-OUTPUT ILLUMINATOR USING  
PARABOLIC/ELLIPTICAL REFLECTOR LAMPS  
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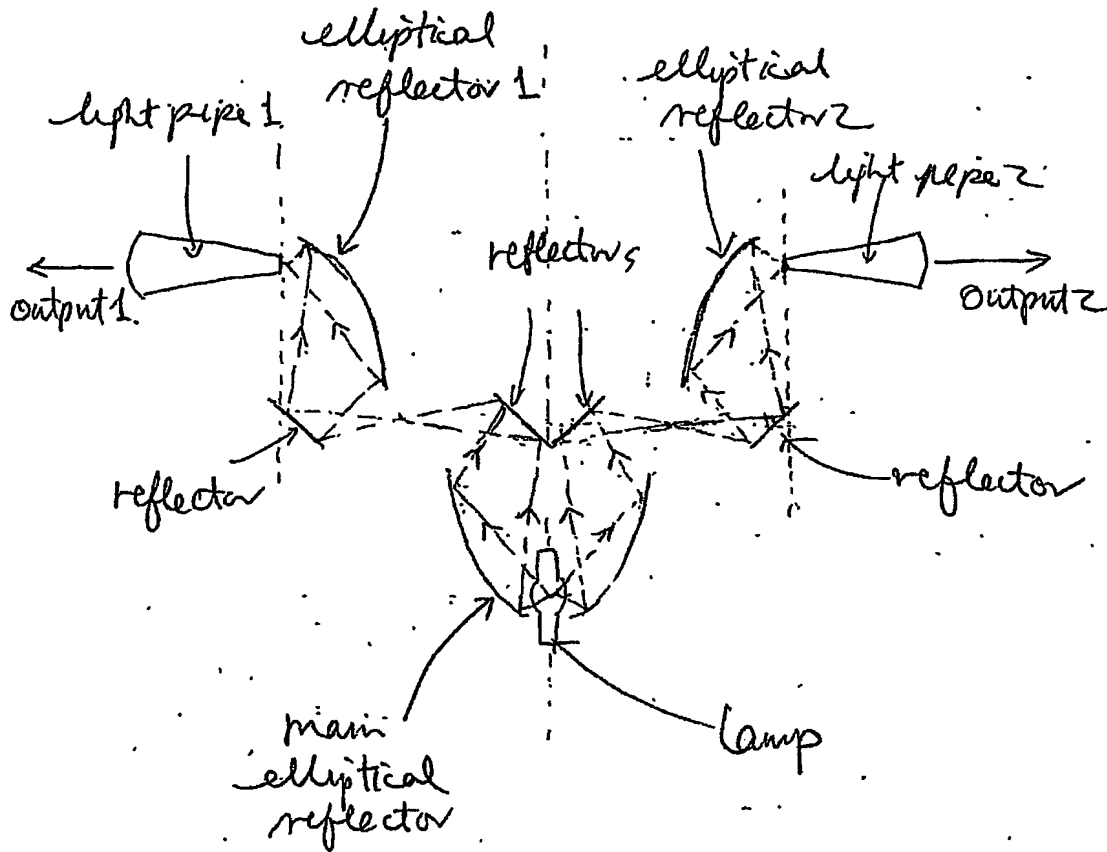


Figure 4